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Development of a Photo Montage Technique for Simulation of Tactical Situations

by

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May 1979

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This report describes a technique developed for presenting imagery of vehicles deployed in tactical array. The technique employed photomontage technology for preparing 35mm transparencies and is described step by step, for the intended audience of military trainers.

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Technical Report TR-79-A17

DEVELOPMENT OF A PHOTO MONTAGE TECHNIQUE FOR SIMULATION OF TACTICAL SITUATIONS

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The Fort Hood Field Unit of the Army Research Institute for the Behavioral and Social Sciences (ARI) provides support to Headquarters, TCATA (TRADOC Combined Arms Test Activity; formerly called MASSTER—Modern Army Selected Systems Test Evaluation and Review). This support is provided by assessing human performance aspects in field evaluations of man/weapons systems.

A war using modern weapons systems is likely to be both intense and short. US man/weapons systems must be effective enough, immediately, to offset greater numbers of an enemy. Cost-effective procurement of improved or new combat systems requires testing that includes evaluation of the systems in operational settings similar to those in which the systems are intended to be used, with troops representative of those who would be using the systems in combat. The doctrine, tactics, and training packages associated with the systems being evaluated must themselves also be tested and refined as necessary.

This report presents the results of an effort designed to develop photographic imagery of combat vehicles in tactical situations. This effort was aimed at producing high quality, low cost imagery usable for a variety of training purposes.

ARI research in this area is conducted as an in-house effort, and as joint efforts with organizations possessing unique capabilities for human factors research. The research described in this report was done by personnel of the Human Resources Research Organization (HumRRO), under contract DAHC19-75-C-0025, monitored by personnel from the ARI Fort Hood Field Unit. This research is responsive to the special requirements of TCATA and the objectives of RDTE Project 2Q763743A775, "Human Performance in Field Assessment," FY 1978 Work Program.

JOSEPH ZEIDNER
Technical Director

DEVELOPMENT OF A PHOTO MONTAGE TECHNIQUE FOR SIMULATION OF TACTICAL SITUATIONS

BRIEF

Requirement:

The work described in this report is related to that referred to in paragraph 2.2.1 of the SOW (revised) dated 16 May 1977 under the title "Study of Target Handoff Techniques." The following objectives guided the course of this effort:

* To develop a methodology for producing visual imagery of tactical arrays of combat vehicles.
* To use these methods to generate a large number of combat situations to support training in target hand-off.

Procedure:

Slides (35mm) of terrain were taken in aircraft flying at realistic NOE altitudes. These were then projected onto a white screen and black-and-white cutout photos of fighting vehicles were attached to the screen. The resulting image was then re-photographed to produce a montage of vehicles emplaced in terrain. Care was taken to match the size of the photos to features in terrain. It was also necessary to match shadows around the vehicles to shadow patterns in the terrain photo. This process yielded 35mm transparencies with considerable optical degradation of the target image. This effect was judged consistent with the real-world viewing environment as experienced by the rotary wing aviator.

Principal Findings:

* Realistic images were obtained when the transparencies were rear projected onto a moderately sized, high quality viewing screen.
* The cost and time involved were felt to be commensurate with the realistic combat simulations obtained.

Utilization of Findings:

The primary product of this effort is a methodology for rapidly producing realistic imagery of combat vehicles in terrain. The cost is very moderate when compared to that incurred by the use of real vehicles and terrain. In addition, it is possible to produce imagery using vehicles which are in the inventories of both NATO and Warsaw Pact vehicles. It is felt that the technique has great promise in producing imagery for a variety of training purposes.

CONTENTS

Chapter 1

INTRODUCTION

A study of problems involved in simulation of target handoff described by Ton, Hemingway, and Chastain[1] indicated that the first priority was the development of a technique for presenting simulated handoff problems. Prior experience had shown that attempts to photograph real vehicles in terrain are time-consuming and costly. In addition, it was felt that considerable realism with a consequent increase in subject motivation could be gained by using threat (Warsaw Pact) vehicles in the handoff problems. Studies of tactics projected for a possible European conflict had further indicated that a likely Soviet tactic would be rapid infiltration of friendly territory to preclude the use of tactical nuclear weapons by NATO forces. Thus, in this hypothetical situation, the pilot of an Attack Helicopter (AH) would be faced with a target-rich environment in which he must correctly discriminate the higher priority target as designated by the scout. The quest for realism also dictates that the target be portrayed at a realistic engagement range; i.e., 2000 to 3000 meters. Therefore, for this research to progress, a method must be devised which would allow the economical presentation of visual imagery with the required characteristics. As structured for the simulation, the handoff problems required that an observer player and an attacker player be presented with two different views of the same target area so that the observer could handoff a target to the attacker. To meet the requirements of tactical realism, the views must also provide the two players with views of terrain containing a mix of threat and friendly vehicles at a realistic engagement range. The range, viewing altitude and bearing of the target must also be varied between the two views.

Obtaining imagery which would meet all of the specifications described above is obviously a considerable technical challenge. This challenge was compounded by the desire to present the pairs of players in the simulation a large number of target handoff problems. The increased number of problems were necessary to allow the players extensive practice and also to permit a more powerful analysis of the nature of the handoff task itself. As 35mm slides had proved satisfactory in the previous work, this format was adopted for subsequent development.

Initial pilot work indicated that the projected images of armored vehicles at realistic engagement ranges were quite small. In addition, a review of Army recognition training literature revealed that there was

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[1] W. H. Ton, P. W. Hemingway, and G. D. Chastain. *Further Study of Target Handoff Techniques*, ARI Technical Report, Human Resources Research Organization, Alexandria, Virginia (in process).

no existing program for the recognition/identification of targets at long range. Hence, it was decided that the projected extensive practice in simulated handoff would be effectively supplemented by training in long range target recognition. This decision provided the impetus for the development of an armored vehicle recognition training slide kit. However, the technology for developing this imagery was fairly similar to that for the handoff slides; both are described in this report.

The process by which the needed imagery was produced for both handoff and recognition is described on the following pages. It is felt that, despite the specificity of the problem, the technology involved in this process will be of general interest for the training community.

Chapter 2

PREPARING THE MONTAGE SLIDES

Both the training slide set and the handoff simulator required imagery that showed a variety of armored equipment, including Warsaw Pact vehicles. Considerable study revealed that the most economical way to obtain the required views was to construct montage slides by superimposing views of models onto real terrain scenes. The basic procedure for making the montage slides was as follows: Slides of terrain were projected on a screen; black and white photographs of tank models were then placed on the projected background so that they appeared to be a part of the scene. The projected image with the superimposed photographs was then photographed using color transparency film. Although this technique had its limitations in that duplications does not yield satisfactory results, it was found that the final product was very realistic. In fact, slides produced with this technique appear more realistic than those of models photographed on sandtables.

Terrain Slides

One of the constraints of the montage technique is that the background slides must have open areas of light color such as grassy areas or areas of bare earth in which the model photos can be placed. If the model photos were placed in an area that contained bushes or other detail, then that detail is superimposed on the vehicle with an unrealistic effect.

The background scenes used to produce the imagery were taken at Fort Hood, Texas, in the Fall of 1977. Slides were shot from a helicopter at altitudes ranging from 50-200 feet. Two 35mm cameras were used so that near and far views of the same area could be obtained. One camera was equipped with a 50mm lens and the other with a zoom lens set to a focal length of 100mm. Therefore, the apparent distance ratio between the far and near views was 2:1.

The background slides were taken on Ektachrome ASA 64 film using a shutter speed of 1/250 - 1/1000 second to avoid blur due to the motion of the aircraft. Some background slides were also taken from a high hilltop. It was found the most useful terrain slides were those taken of areas that had several tree lines separated by open areas. The grass was of a straw color so that the models contrasted quite well in the montage slides. All of the background slides were taken at midday in a northerly direction to assure even illumination by the sun. When a good terrain area was found, 10 to 12 shots were taken from various angles, resulting in a large number of usable picture combinations. Handling two cameras was difficult so that most shots were taken with the 50mm lens while the camera with the longer lens was used to record three or four shots of each area. All terrain slides were shot pointing the camera down at an angle which did not exceed 10 to 20 degrees.

Models

The models used for the target imagery were 1/87 or HO scale plastic models obtained from local hobby shops. Larger, 1/35 scale, models of some armored vehicles were also available, but it was found that a greater variety of vehicles was available in the smaller scale. The 1/87 models usually had adequate detail, but it was necessary to alter several to look more like their prototypes. Since no model of the Soviet T-62 tank was available, one was made from a T-54 model by re-arranging the roadwheels and altering the turret and gun. Small searchlights and grab rails were also added to the turret. A searchlight and storage rack were also added to the US M60 tank model, and an M109 SP Howitzer was made from an M108 by adding a larger gun. To eliminate reflections, the models were sprayed with a flat olive drab paint.

The models used are listed in Table 2-1. In addition to those models, a model of the French Roland missile system was also used in some of the training imagery. The Roland, when seen from a distance, is similar to several other vehicles. No recognition lesson was prepared for the Roland because of the small number of available photographs of the vehicle.

The vehicle models were photographed on a white background using Plus-X black and white film. The lighting consisted of a single strobe flood unit mounted high and behind the camera. The flood was covered with tissue paper to achieve a diffused lighting. The vehicle models for use in training were photographed at four combinations of azimuth and elevation angle.

Azimuth	Elevation
45°	20°
90°	10°
270°	10°
315°	20°

The negatives were developed and small prints were prepared of each model. The models were printed rather light in tone so that they would not appear too dark in the montage slides.

Montage Slides

Two carousel projectors were placed about 8 feet from a large free standing blackboard. Large sheets of white paper were taped to the blackboard to serve as screens for the projectors. Several types of paper and white cardboard were tried until one was found that closely matched the "whiteness" of the print paper used for the model photos. It was found that the paper contained in the large tablets commonly used on easels for briefings gave a background on which the edges of the prints were often undetectable.

Table 2-1. Vehicles Contained in the Recognition Slide Kit

Origin	Model	Type
US	M60	Tank
US	M551	Sheridan Tank
US	M113	APC
US	M109	SP Howitzer
British	Chieftain	Tank
British	Scorpion	Reconnaissance Vehicle
German	Leopard	Tank
German	Gepard	Antiaircraft System
Soviet	T-62	Tank
Soviet	T-54/55	Tank
Soviet	BTR-60P	Personnel Carrier
Soviet	ZSU-57	Antiaircraft Gun

The training kit required a number of slides showing a group of six different armored vehicles located on a terrain background (Figure 2-1). Transfer letters were used to designate the different vehicles. A terrain slide was selected that seemed to match the elevation angle of the required tank photos and then the photos were positioned on the projected background so that they "looked right." Each vehicle photo was cut from the print leaving a white border around the image 1/2 to 3/4 inches wide. The cutout images were then attached to the screen with small pieces of double sided tape. After the photos were arranged on the screen, some shadowing was drawn around the base of each vehicle with a felt tip pen to match the shadows shown in the terrain background. If the shadows were not drawn in, the vehicles seemed to "float" away from the terrain. The black and white model photos also tended to pick up some of the background color from the slide so that they no longer appeared as shades of gray.

The resulting composite scene was then photographed with color slide film. Both tungsten film and daylight color film were used to make montage test shots and it was found that the best results were obtained with daylight Ektachrome film. The 500 watt bulbs of the projectors gave a rather warmish slide with the tungsten film; this was compensated by the bluish tendency of the daylight film which resulted in an overall pleasing tone to the slide.

The scenes were photographed using a 35mm camera with a 70-210mm zoom lens mounted on a tripod just above and behind the projector.

Due to the nature of the light produced by the projector bulb, it was found that normal light meter readings based on the film speed were not accurate. Therefore, a test roll was taken so that the best exposure could be determined. Once the correct exposure value was determined, then the camera's through-the-lens light meter was adjusted to give that exposure under the same set of conditions. Additionally, exposures were bracketed by $\pm 1f$ stop as insurance for good exposures. Kodak Ektachrome, type EPR (ASA 64) and type EPD (ASA 200) were used to photograph the training and simulator imagery. Typical exposures for the EPR film were 1/4 sec. at f3.5 and 1/4 sec. at f5.6 for the EPD film. The latter film seemed to give slightly better results, due probably to the smaller lens opening and its slightly bluer rendition which further counteracted some of the orange in the projector's light. The best montage slides resulted from terrain slides that were on the thin side and of lower contrast. The montage slides that resulted from the process described above appear quite realistic, as may be seen in Figure 2-1.

Figure 2-1. Print prepared from montage slide.

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Handoff Imagery

Photographing the montage slides for the handoff simulator was more difficult than making the montage imagery for the recognition training slide kit. The handoff imagery required that the vehicles shown in the observer's slide be shown in the same locations in the attacker's slide. The two views of the vehicle had to differ by the same angle as did the two terrain shots. The two slides also had to show a meaningful scenario as described in Chapter 3 of the report by Ton, Hemingway, and Chastain.[1]

Terrain background slide pairs were projected side by side to determine an appropriate scenario. When a scenario was decided upon, vehicles were chosen and their placement and relative angular positioning between the two views of a vehicle was determined so that prints could be made. The technique for producing these montage slides was the same as used for the recognition training kit.

In addition to the model negatives used for the recognition training slides, other model negatives were taken of the model set at azimuth angles of 45°, 75°, 285°, and 315° at an elevation angle of 10°. All of these model negatives were printed on proof sheets so that appropriate views could be easily selected. It was found that these four azimuth views gave an adequate selection of angular views to satisfy the requirements of the terrain background slides. The proper target views were chosen by comparing the proof sheet to the projected background slide. Vehicle sizes were chosen subjectively to match the terrain. Overall, the resulting transparencies were judged quite realistic. The images were generally superior to those obtained with models on a terrain board.

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[1] W. H. Ton, P. W. Hemingway, and G. D. Chastain. *Further Study of Target Handoff Techniques,* ARI Technical Report, Human Resources Research Organization, Alexandria, Virginia, (in process).

Chapter 3

CONCLUSIONS

The process of making the montage slides was rather *time-consuming* due to the number of steps involved. The resulting slides were sometimes not completely sharp. However, a certain amount of blur added to the realism of the imagery as the actual viewing environment of the pilot would be degraded by vibration and atmospheric conditions. Even so, sharp originals and good quality projection lenses are necessary. The lenses used to photograph the projected image should also be of high quality. Cameras and projectors should also be solidly mounted to avoid vibration problems. Quality could be further improved by using originals photographed in a format larger than 35mm. In addition, the possibility of using films different from those used in the current project should be explored. It is possible that quality would be improved by using special purpose high contrast film in the copying stage. Slow, fine grain color transparency film may also be better suited for obtaining terrain imagery. Finally, the generality of the method could be improved by utilizing equipment of the sort generally found in audiovisual support units.

It is recommended that this technique be explored further with the aim of developing a process of suitable generality to allow its widespread use. The need for low-cost, high fidlity imagery for use in training target identification is great. The method described in this report is capable of fulfilling these needs without great expenditure of time or money.